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(54) Title: CHANNELIZATION AND ENCODING FOR TEXT INFORMATION SERVICES TRANSMITTED VIA RADIOCOMMUNICATION SYSTEMS

(57) Abstract

The present invention sets forth techniques for channelizing and encoding various broadcast information services using, for example, a broadcast control channel to provide information to a mobile station user. The mobile station may be a receive–only device, similar to a simple pager, or may be a receive/transmit device, such as a mobile phone. In order to limit the capacity of the broadcast channel that is consumed by, e.g., a Security Quote service, an efficient encoding and channelization method is provided. The method includes separating the short–message–service broadcast control channel into 3 logical sub–channels: a Security Name channel, a Start Value channel and a Delta channel. These channels provide different aspects of the securities information to the mobile station. By varying the bandwidth allocation of these individual channels, the present invention is capable of providing a very large amount of securities while also maintaining a fast cycle time.

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# CHANNELIZATION AND ENCODING FOR TEXT INFORMATION SERVICES TRANSMITTED VIA RADIOCOMMUNICATION SYSTEMS

## RELATED APPLICATIONS

This application is related to, and claims priority from, U.S. Provisional Patent Application Serial No. 60/088,845, filed on June 10, 1998, entitled "High Bandwidth Text Information Services for Radiocommunication Systems" to Alex K. Raith and U.S. Provisional Patent Application Serial No. 60/089,280, filed on June 15, 1998, entitled "Headline Hyperlink Broadcast Service", also to Alex K. Raith. The disclosures of both of these provisional applications are expressly incorporated here by reference.

## BACKGROUND

The present invention relates generally to the provision of information services in radiocommunication systems and, more particularly, to the encoding and channelization of data for broadcast transmission over an air interface to efficiently provide broadcast information services in conjunction with existing radiocommunication services and systems.

The growth of commercial radiocommunications has been dramatic over the last fifteen years. Pagers and cellular phones, in particular, stand out as relatively common equipment in many urban settings. These two different types of communication devices, and supporting systems, have evolved from different fundamental purposes, i.e., pagers for traditionally providing one-way, limited information to one or more end users and cellular phones for traditionally providing two-way voice communication service.

As time and technology progress, the traditional functional dividing lines between these two different types of radiocommunication devices have blurred. Pagers have acquired some of the functionality that was traditionally provided by

cellular phones and vice-versa. For example, two-way pagers have been developed which permit the pager user to transmit messages to the paging system, which messages can then be forwarded to other parties. Similarly, cellular phones have acquired the capability to transmit and receive short (e.g., on the order of 160 alphanumeric character) text messages which can be output on the display of a cellular phone. This evolution in radiocommunication devices has led to the development and marketing of a host of new information services.

For example, paging systems have been implemented which provide for the broadcast of information services, e.g., stock quote information services, to a large number of subscribers that have pagers with displays. These pagers periodically receive information over an air interface associated with a large number of stocks or other financial instruments such as options, futures, etc., and display the current prices of these instruments so that a user can track his or her portfolio's performance.

Applicant anticipates that users of cellular phones would have interest in the provision of a similar service which would provide information service support in a cellular network. However, cellular systems, unlike paging systems, have conventionally been designed around the paradigm of (1) limited bandwidth due to a restriction on the spectrum allocated by various governing bodies, e.g., the FCC, for cellular applications and (2) the notion that most of the limited bandwidth be reserved for point-to-point connections (e.g., voice connections) between the cellular phones and the system, with only a relatively small fraction being reserved for broadcast, i.e., point-to-multipoint, transmissions from the system to the cellular phones operating in the system. Due to this latter feature of cellular systems in particular, system designers are very careful regarding the amount of information transmitted on the available broadcast channels and the frequency with which this information is repeated. Thus, the provision of broadcast information services to cellular radiocommunication systems cannot

readily be accomplished by the most straightforward approach of simply broadcasting whatever information is desired for all subscribers to display on their cellular phones.

Consider, for example, a TDMA cellular radiotelephone system, wherein each radio frequency is divided into a series of time slots, each of which contains a burst of information from a data source, e.g., a digitally encoded portion of a voice conversation. By time multiplexing bursts associated with different sources, more than one channel can be supported on each radio frequency. The time slots are grouped into successive TDMA frames having a predetermined duration. The number of time slots in each TDMA frame is related to the number of different users that can simultaneously share the radio channel. If each slot in a TDMA frame is assigned to a different user, the duration of a TDMA frame is the minimum amount of time between successive time slots assigned to the same user.

The successive time slots assigned to the same user, which are usually not consecutive time slots on the radio carrier, constitute the user's digital traffic channel (DTC). As mentioned above, this is typically a point-to-point resource and, in fact, most TDMA systems reserve the majority of the available radio channels for use as DTCs to ensure a large traffic capacity. However, as described in more detail below, digital control channels (DCCHs) are also provided for communicating control signals and overhead information, including a mechanism for connecting to the radiocommunication system and being assigned a DTC.

Similar types of resource allocations are found in other types of cellular systems. For example, in code division multiple access (CDMA) systems, channelization is performed by spreading data associated with a particular connection using a unique spreading code. This code, as opposed to or in conjunction with frequency and time differentiators, provides the receiver with a mechanism for extracting its intended data, i.e., by correlating the received

composite signal with the code assigned to its traffic channel. Like TDMA systems, CDMA systems can also provide for broadcast control channels or other overhead signalling channels by allocating known codes thereto. However, like TDMA systems, CDMA systems also tend to reserve more resources (e.g., codes and power) for dedicated traffic channels than for broadcast information channels.

Accordingly, it would be desirable to provide techniques and systems which are able to provide broadcast information services within the constraints of existing cellular radiocommunication systems. In particular, it would be desirable to design broadcast information techniques and systems such that they accommodate an end user's desire for a relatively large quantity of data that may need to be updated relatively frequently, while minimizing the usage of scarce broadcast channel resources.

## SUMMARY

Exemplary embodiments of the present invention provide techniques which support broadcast information services via radiocommunication systems using a broadcast resource in an efficient manner. The end user's equipment, e.g., mobile station, may be a receive-only device, similar to a simple pager, or may be a receive/transmit device, such as a mobile phone. The present invention minimizes the capacity of the broadcast resource that is consumed by the broadcast information service by providing efficient encoding and channelization of the transmitted information.

According to a purely illustrative, exemplary embodiment of the present invention, the broadcast information service can be a security quote service which is provided in an IS-136 compliant system having broadcast short-message-service (SMS) capability. The portion of the broadcast control channel which has been reserved in IS-136 for SMS can be further separated into a plurality of logical sub-

channels for carrying various portions of the data used to implement the security quote service. More specifically, these exemplary sub-channels can include a Security Name channel, a Start Value channel and a Delta channel.

These channels carry different aspects of the securities information to the mobile station. By varying the bandwidth allocation of these individual logical sub-channels, the present invention is capable of providing information associated with a large number of securities while also maintaining a fast refresh rate (cycle time).

Other exemplary embodiments of the present invention provide techniques for channelizing and coding information associated with sports scores to allow for efficient transmission over broadcast resources of a radiocommunication system. The present invention can be generalized to any given set of information to be transmitted.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and features of the present invention will be more apparent from the following description of the preferred embodiments with reference to the accompanying drawings, wherein:

Figure 1 illustrates a generalized view of a digital control channel (DCCH) having time slots which are grouped into superframes;

Figure 2 illustrates an exemplary radiotelephone system into which the present invention may be implemented;

Figure 3 illustrates a hyperframe structure according which can be used to implement the present invention;

Figure 4 illustrates the logical channels of the DCCH which can be used to implement the present invention;

Figures 5-7 illustrates a further exemplary subdivisions of logical channels used to broadcast information associated with a security quote service according to the present invention;

Figures 8 and 9 illustrate a generalization of channelization and coding techniques according to the present invention.

## DETAILED DESCRIPTION

The following description is written in terms of a cellular radiotelephone system, but it will be understood that Applicant's invention is not limited to that environment. Also, the following description is written in the context of IS-136 compliant, TDMA cellular communication systems, but (as mentioned above)it will be understood by those skilled in the art that the present invention may be implemented in other digital communication applications including those which are designed in accordance with other standards, e.g., GSM or PDC, and those which use CDMA as an access methodology, e.g., IS-95.

In particular, exemplary embodiments of the present invention describe techniques and systems for providing broadcast information services which are intended to minimize the usage of the relatively scarce broadcast resources available in existing cellular radiocommunication systems. Accordingly, these exemplary embodiments are described using the broadcast resources available in IS-136, in particular the broadcast SMS channel (S-BCCH). Some of the details associated with IS-136 systems generally and the broadcast SMS channel specifically are described below, while others are omitted to avoid obscuring the present invention. However, the interested reader is referred to U.S. Patent No. 5,603,081 to Raith et al. and U.S. Patent Application Serial No. 08/482,754 also to Raith et al. for additional information pertaining to IS-136 related systems generally and broadcast SMS techniques specifically, respectively. The

disclosures of both the aforementioned U.S. Patent and U.S. Patent Application are expressly incorporated here by reference.

Figure 1 shows a general example of a forward (or downlink) DCCH configured as a succession of time slots 1, 2, ... , N, ... included in the consecutive time slots 1, 2 ... sent on a carrier frequency. These DCCH slots may be defined on a radio channel such as that specified by IS-136, and may consist, as seen in Figure 1 for example, of every n-th slot in a series of consecutive slots. Each DCCH slot has a duration that may or may not be 6.67 msec, which is the length of a DTC slot according to the IS-136 standard.

As shown in Figure 1, the DCCH slots may be organized into superframes (SF), and each superframe includes a number of logical channels that carry different kinds of information. One or more DCCH slots may be allocated to each logical channel in the superframe. The exemplary downlink superframe in Figure 1 includes three logical channels: a broadcast control channel (BCCH) including six successive slots for overhead messages; a paging channel (PCH) including one slot for paging messages; and an access response channel (ARCH) including one slot for channel assignment and other messages. The remaining time slots in the exemplary superframe of Figure 1 may be dedicated to other logical channels, such as additional paging channels PCH or other channels. Since the number of mobile stations is usually much greater than the number of slots in the superframe, each paging slot is used for paging several mobile stations that share some unique characteristic, e.g., the last digit of the MIN.

Figure 2 represents a block diagram of an exemplary cellular mobile radiotelephone system, including an exemplary base station 110 and mobile station 120. The base station includes a control and processing unit 130 which is connected to the MSC 140 which in turn is connected to the PSTN (not shown). General aspects of such cellular radiotelephone systems are known in the art, as described by U.S. Patent No. 5,175,867 to Wejke et al., entitled "Neighbor-

Assisted Handoff in a Cellular Communication System," and U.S. Patent Application No. 07/967,027 entitled "Multi-mode Signal Processing," which was filed on October 27, 1992, both of which are incorporated in this application by reference.

The base station 110 handles a plurality of voice channels through a voice channel transceiver 150, which is controlled by the control and processing unit 130. Also, each base station includes a control channel transceiver 160, which may be capable of handling more than one control channel. The control channel transceiver 160 is controlled by the control and processing unit 130. The control channel transceiver 160 broadcasts control information over the control channel of the base station or cell to mobiles locked to that control channel. It will be understood that the transceivers 150 and 160 can be implemented as a single device, like the voice and control transceiver 170, for use with DCCHs and DTCs that share the same radio carrier frequency.

The mobile station 120 receives the information broadcast on a control channel at its voice and control channel transceiver 170. Then, the processing unit 175 evaluates the received control channel information, which includes the characteristics of cells that are candidates for the mobile station to lock on to, and determines on which cell the mobile should lock. Advantageously, the received control channel information not only includes absolute information concerning the cell with which it is associated, but also contains relative information concerning other cells proximate to the cell with which the control channel is associated, as described in U.S. Patent No. 5,353,332 to Raith et al., entitled "Method and Apparatus for Communication Control in a Radiotelephone System," which is incorporated in this application by reference.

The mobile station 120 also includes an input device 185, such as a numeric keypad, which allows a user to interact with the mobile station. A

display device 190, such as an LCD screen, provides a visual display of information to the user. The mobile station also includes memory 180.

In exemplary embodiments of Applicant's invention, the transmission of broadcast information from base stations to mobile stations is structured into successions of different kinds of logical frames. Figure 3 illustrates the frame structure of a forward (base station to mobile station) DCCH according to IS-136 and shows two successive hyperframes (HF), each of which preferably comprises a respective primary superframe (SF) and a respective secondary superframe. It will be recognized, of course, that a hyperframe could include more than two superframes.

Three successive superframes are illustrated in Figure 3, each comprising a plurality of time slots that are organized as logical channels F-BCCH, E-BCCH, S-BCCH, and SPACH that are described in more detail below. At this point, it is sufficient to note that each superframe in a forward DCCH includes a complete set of F-BCCH information (i.e., a set of Layer 3 messages), using as many slots as are necessary, and that each superframe begins with a F-BCCH slot. After the F-BCCH slot or slots, the remaining slots in each superframe include one or more (or no) slots for the E-BCCH, S-BCCH, and SPACH logical channels.

Referring to Figure 3, and more particularly to Figure 4, each superframe of the downlink (forward) DCCH preferably comprises a broadcast control channel BCCH, and a short-message-service/paging/access channel SPACH. The BCCH comprises a fast BCCH (the F-BCCH shown in Figure 3); an extended BCCH (the E-BCCH); and a short-message-service BCCH (the S-BCCH), some of which are used, in general, to carry generic, system-related information from the base stations to the mobiles.

The F-BCCH logical channel carries time-critical system information, such as the structure of the DCCH, other parameters that are essential for accessing the system, and an E-BCCH change flag which is described in more detail in U.S.

Patent Application No. 08/482,754, which is commonly assigned and incorporated herein by reference; as noted above, a complete set of F-BCCH information is sent in every superframe. The E-BCCH logical channel carries system information that is less time-critical than the information sent on the F-BCCH; a complete set of E-BCCH information (i.e., a set of Layer 3 messages) may span several superframes and need not be aligned to start in the first E-BCCH slot of a superframe. The S-BCCH logical channel carries short broadcast messages, such as stock information, advertisements and other information of interest to various classes of mobile subscriber. According to exemplary embodiments of the present invention, this logical channel may be used to support information services, for example a security quote service or a sports information service.

**An Exemplary Security Quote Service**

In determining how to efficiently use an existing broadcast resource to support a new information service, e.g., a security quote service, it is first important to determine what type of information needs to be broadcast, the amount of information involved and how frequently that information needs to be retransmitted. For example, securities information transmitted as part of a broadcast security quote service would preferably include the security symbol or security name, the base trading value associated with each symbol (i.e., the previous day's closing price) and a value which represents the increment or decrement to the base value at a given time of day. Depending on the length of the security symbol and the number of digits used to represent its corresponding value, the number of octets required to be transmitted per entry could be as high as 20. With 8 bits per character, the total number of bits is approximately 160 bits. By implementing some simple restrictions on the transmission format, such as not sending spaces, the required amount of data can be reduced by a few octets. However, such formatting requirements may impose unwanted restrictions, such

as requiring that a stock symbol not end with a digit. These restrictions may not be compatible with current or future stock symbol transmission formats.

Imposing restrictions on the transmission format may reduce the amount of data needed to be transmitted; however, such systems will still require a relatively large amount of data per security symbol to be transmitted. In exemplary embodiments of the present invention, the S-BCCH logical channel includes at least three logical sub-channels which support this broadcast information service: a Security Name channel, a Start Value channel and a Delta channel as seen in Figure 5. One skilled in the art will appreciate that the S-BCCH logical channel could be divided into more than three logical sub-channels without departing from the spirit and scope of the present invention and that, presumably, other SMS activities would in fact be supported by different logical sub-channels. For example, as described in the above-identified and incorporated by reference U.S. Patent Application Serial No. 08/482,754, the S-BCCH may be divided into n (e.g., 32) sub-channels that support different broadcast services, service levels, etc. Any one of these sub-channels (as seen in Figure 6) or more than one of these sub-channels (as seen in Figure 7) may be further logically subdivided to include the three sub-channels described herein.

The Security Name sub-channel can include information which allows the mobile station to map a received symbol, e.g., transmitted on the Start Value or Delta channel, to a security name for displaying the more readily understood security name at the mobile station. The mapping information can be read from the Security Name sub-channel and stored in the mobile station for later use. For example, the Security Name sub-channel could include a stream of symbols, e.g., "ERICY", followed by their corresponding security name, e.g., "ERICSSON". The mobile station can store this mapping. Then, if the Start Value or Delta Channel includes the symbol "ERICY" which the mobile station could then look

up in its memory and display as "ERICSSON" on the mobile station's display, along with a current stock value.

Along with this mapping information, the Security Name sub-channel can also provide the type of encoding used by the information service provider (e.g., an identifier of the type of information and/or format of the information provided on the Start Value and/or Delta channel, see the exemplary alternatives described below) and a multi-bit (e.g., 8 bit) change flag (CF) which indicates whether the mobile station should read the remaining information broadcast on this sub-channel for the purpose of updating its stored information. The CF may be system operator code (SOC) specific, country code specific or specific to both, which characteristic of the change flag may also be transmitted therewith. Interpretation of the CF by the mobile station can be controlled by over the air programming, e.g. OATS in IS-136, or sent in the Delta channel.

The CF can be implemented as a date value in order to determine whether updating of the information which is broadcast on the Security Name channel is required. By using a date for the CF, a mobile station that travels between un-coordinated service providers would not have to repeatedly update this information as supplied by the different providers. The mobile station would instead only change its stored data if the CF indicates a more recent date than that which is stored with the data.

As noted above, the content of the Security Name channel primarily includes a mapping of the official security symbols (which do not change frequently) to the popular or legal name of the security and encoding information. As a result, the frequency of changes to the information broadcast on this channel is very low, which allows exemplary embodiments of the present invention to allocate a relatively low bandwidth to the transmission of this sub-channel. Moreover, the bandwidth allocation can vary based on, for example, time of day as described below.

Since the information broadcast on the Security Name channel should require relatively infrequent updating, the scenario of having a mobile traveling between uncoordinated service providers is not a large concern. If one service provider is sending a vastly different set of securities than another service provider, it would only affect the other two channels (i.e., the Delta and Start Value channels). If one service provider is sending a symbol for which the mobile station has no stored security name, the mobile station will then display the symbol, instead of the name, to the user. The names stored in the mobile need not be cleared if they are not found on the Security Name channel broadcast by another provider; instead, the mobile station can add names to its stored mapping as it travels between service providers.

More drastic changes in this information being broadcast may be experienced by a traveling mobile station which moves from one country to the next, e.g., a broadcast information service provider in France may broadcast a list of symbols and corresponding security names for the French stock market, after receiving which a mobile station may enter Germany and read information associated with the German stock market. According to an exemplary embodiment of the present invention, when a different country code is detected in the overhead information broadcast from a radiocommunication system, the mobile station either clears the symbol-to-name mapping associated with the first country code from its memory or, preferably, creates a new symbol-to-company name list for the new country code. If the mobile generates a new symbol-to-name mapping, it can simply switch back to the old mapping when it travels back to the previous country, e.g., as recognized by the mobile station's receipt of the old country code. This allows the mobile station to maintain in its memory its home country security mapping while traveling abroad. Furthermore, the mobile can learn the symbol-to-name mapping of the country that it is visiting.

The Security Name channel can also provide a category value. The securities, according to the present invention, may be sub-divided into such categories as types of companies (e.g., telecommunications companies), metals, currencies, etc. If a change has occurred in one security, sub-dividing the securities into sub-lists and into types of securities would eliminate the need to reprogram the entire set of names; however, such a subdivision would possibly require multiple CFs and type identifiers.

As indicated above, the mobile may store more than one list and associated CF. This eliminates reloading the company name list when roaming between country codes or different service providers. Of course, one skilled in the art will appreciate that it would be desirable to have lists that are common to multiple service providers in the same country or, more specifically, an area covered by one common securities exchange, e.g., Vatican and Italy.

The information to be conveyed in the Security Name channel can also be sent in other ways than over the S-BCCH. For example, using the over-the-air activation service as defined in IS-136, downloading this information using a cellular/PCS/satellite data service or from a website on the Internet which is programmed into the mobile station via, e.g., an infrared link between a portable computer and the phone. In these cases, updating of the symbols to the name of the securities may not be as rapid or automatic, but will reduce the usage of bandwidth on the broadcast resource.

As mentioned above, since the information transmitted on the Security Name sub-channel need not be updated frequently, which is beneficial since this channel may contain a relatively large amount of data. The issue of when the Security Name information will be updated can be better understood in the context of the following example. Assume that about 10 octets (i.e., eight bit characters) are needed for each security name and about four octets for each symbol. Given some overhead information that is needed, e.g., 15 octets or 120 bits, the total

number of bits that need to be transmitted and read by a mobile station for a 1000 security set is then 120,000 bits. If it is assumed that 10% of an S-BCCH slot is allocated to the Security Name sub-channel, then it would take 120,000 /(0.6*0.1) or approximately 2 hours in cycle time for this information to be refreshed. However, a user may prefer more rapid updating of this information.

One option is to increase the bandwidth used for this channel, i.e., use more than 10% of an S-BCCH slot to convey the Security Name sub-channel. Another option is to not send this channel during the trading day. Instead, the mobile station can use whatever mapping is available in memory during the trading day (which implies that the mobile station may be preprogrammed with a mapping between symbol information and a security name for fast, initial use of the service). The mobile station can continue to present the old (prestored) name until such time as it updates the name information while reading the Security Name channel after the trading day ends. Alternatively, instead of preprogramming the mobile station, the mobile could simply display the symbol name, if it is transmitted on the Start Value and/or Delta channel, until such time as the mobile station receives the security name information.

The second sub-channel to be described is the Start Value channel. The main content of the Start Value sub-channel is the end-of-day trading value for a particular symbol. Along with the end-of-day trading value, the Start Value channel also provides the type of encoding (i.e., format) used by the service provider for this channel, the date of the last trade of a security, and a date for which the trading value is valid as a start value. This validity date is used to prevent the mobile station from re-reading the Start Value channel during an inactivity period (i.e., during a period in which there is no trading). In an exemplary embodiment of the present invention, the date of the last trade and the validity date can be merged; however, for applications that are date sensitive (e.g., applications performing statistical analysis and comparisons), it may be

advantageous to transmit the actual date of the last trading day as a separate information element.

In addition to the above information, the Start Value channel can also provide a list number, a sub-list number (if necessary), the number of Security Symbol (SS) entries, and a list entry number. The list entry number can be specific to a particular list or common for all lists. It is possible to eliminate the transmission of the list entry number in order to reduce the amount of data to be transmitted; however, the value may facilitate the retrieval of data in the presence of word errors if it is sent along with the SS.

The Delta channel provides a value which represents an increment or decrement from the start value for a particular symbol. Along with the increment/decrement value, the Delta channel also provides the type of encoding used by the service provider for the information found on this channel, the time of day, a list number, and a sub-list number. The list number allows the service provider to control the type of security to which a user is permitted access. For example, the user may only have subscribed to a limited number of securities from the New York Stock Exchange. Similarly, through the use of a sub-list number, a user may only be permitted access to a certain set of a list transmitted. For example, the user may only be permitted access to telecommunication companies on NASDAQ. Each entry in a list has a list entry number assigned to it.

Many different encoding techniques or formats may be used for the Delta channel. To the extent that different service providers may opt for different encoding techniques, information which identifies the encoding technique should also be broadcast so that the mobile station can properly interpret the received information. Several exemplary encoding techniques for the Delta channel are described herein, but those skilled in the art will appreciate that other techniques may be used and are considered to be within the scope of the present invention.

For example, the symbol information, e.g., "ERICY", may be transmitted on the Delta channel to explicitly indicate the correspondence between a security and each increment/decrement value transmitted on the Delta channel. Alternatively, e.g., if it is desirable to reduce the bandwidth requirements of the Delta channel and/or increase the refresh rate of the increment/decrement information, the symbol identity information may be omitted completely, in which case the order of the increment/decrement values will implicitly connote the symbol identity associated therewith. If this latter option is used, then in some overhead information which is transmitted periodically on the Delta channel, a reference value (e.g., a number which indicates the current position in the symbol sequence) should be provided to allow the mobile station to synchronize to the information when it begins to read information on the Delta channel starting at some arbitrary time.

A compromise between the two options of explicitly sending the symbol value and relying on only the implicit information associated with a sequence in which increment/decrement values are transmitted to identify the symbol is to send, in addition to the increment/decrement value, a reference number that identifies the symbol. For example, if a universe of 65,000 securities are supported by the broadcast information service, then a reference number having 16 bits can be sent along with each increment/decrement value. The reference number can be pre-stored in the mobile station and/or can be received on the Security Name channel along with the other information previously described.

The incremental/decremental symbols are sent sequentially over the Delta channel starting from the beginning of the list or sequence of the list. Assuming that no symbol reference information is transmitted explicitly, the content of the list may, for example, be represented as: +1;38,-11;18,+12;132, which is decoded by the mobile station as: +1 3/8, -11 1/8, +12 1/32. The list can also include some general overhead information, such as a time stamp. This exemplary

format for transmitting information on the Delta channel is based on the assumption that changes are represented as an integer number and/or a fractional value. If, on the other hand, decimal changes are used, a decimal representation could be provided or the decimal change could be represented as a fraction with some predefined loss of accuracy, e.g., as eighths or thirty-seconds.

Most securities, at least on the U.S. market, do not vary in value on any given day by more than what can be represented with one digit (1-9) for the integer portion of the price representation. Thus, this exemplary embodiment of the present invention provides for four bits to represent the integer portion of the price of each security. Moreover, assume that each fraction is quantized to increments of 1/32 such that the fractional portion of the price representation can be transmitted on the Delta channel using 5 bits. Then, the total number of bits per symbol to be transmitted on the Delta channel would be eleven, including one bit each for the plus/minus symbol and an indicator as to whether additional integer values followed (e.g., when the change was greater than 16 dollars for a particular security). If a decimal format is used, then 7 bits (to represent the decimal fraction to an accuracy of hundredths) are needed for the fractional part, raising the total to 13 bits per symbol or security.

Compare the foregoing exemplary embodiment using the Delta channel concept to a more straightforward implementation where all of the necessary information including complete security name, full current value of the security, etc. were transmitted in each instance. For such an implementation, Applicant envisions that somewhere between about 100-160 bits per security would be needed, which illustrates the dramatic reduction in broadcast bandwidth achieved utilizing the present invention. Without the channelization and encoding described herein, this tenfold increase in data to be transmitted would likely render such a service unfeasible either due to a lack of sufficient broadcast channel bandwidth or due to an unacceptably slow (from the user's perspective) refresh rate.

To further understand the advantages associated with the present invention, consider the following example. The service may categorize the securities in sub-sets, e.g., national, foreign, futures, commodities, currency, etc. For a set of one thousand securities, the number of bits required to transmit this information (without a symbol reference as described above) over the Delta channel is about 1000*11 (using the first example given above) or 11,000 bits. Some overhead (e.g., time stamp info, message types, sub-channel identifier, etc) would increase this number slightly to, e.g., about 15,000 bits.

The net number of bits per Layer 2 frame of the S-BCCH is expected to be about 100 bits. Thus, the throughput on a timeslot per superframe basis is 100/0.6 or about 166 bits per second. It would, therefore, take about 90 seconds to transmit information for 1000 securities (without considering bit errors), if only one time slot per superframe was allocated to this service and assuming that all of this bandwidth was used for the Delta channel (see the discussion below regarding the time variation of bandwidth). If three timeslots per superframe were used, then the refresh cycle could be reduced to 30 seconds. Other bandwidth allocations are, of course, possible and within the scope of the present invention.

In order to increase the efficiency of the security quote service, the bandwidth allocation to the individual security quote sub-channels can be varied dependent upon the status of the securities market, e.g., the time of day. When the market is open for trading, the majority of the bandwidth is allocated to the Delta channel. This is due to the fact that, as indicated above, the Delta channel provides the incremental/decremental value of the security, which continuously changes (i.e., requires updating) throughout the period in which trading is occurring. On the other hand, after the market is closed and until the market opens again, most of the bandwidth is assigned to the Start Value channel. The Security Name channel will be a relatively low bandwidth channel which may be transmitted only when the market is closed, since it is envisioned that this channel

will require reading relatively infrequently to handle the cases where, for example, a stock symbol may be assigned to another company or the name of a company may be modified.

Tables 1-3 summarize potential bandwidth allocations for some of the S-BCCH sub-channels of the present invention during both opened and closed markets. In the following description, those skilled in the art will appreciate that exemplary references to numbers of S-BCCH time slots should not necessarily be interpreted literally, but rather as reflecting an effective multiplexing rate of the logical sub-channels into the S-BCCH. Before the market opens, the broadcast bandwidth allocated to the Start Value channel can be 1, 2 or 3 S-BCCH time slots as is illustrated in Table 1. The Delta channel may have no bandwidth and the Security Name channel may have a relatively low bandwidth, e.g., ½ or 1/3 of a slot. The cycle times are based on, among other things, the earlier described exemplary encodings for price representations.

| S-BCCH sub-channel | No. of S-BCCH slots | Cycle time |
|---|---|---|
| Start Value | 1 | <7 minutes |
| Start Value | 2 | <4 minutes |
| Start Value | 3 | 2+ minutes |

TABLE 1

Table 2 summarizes a potential allocation for the Start Value channel during the time when the market is open. It will be seen that the Start Value bandwidth will be reduced, so that the Delta channel may have the majority of the bandwidth available for this service, while the Security Name channel may have low or zero bandwidth.

| S-BCCH sub-channel | No. of S-BCCH slots | Cycle time |
|---|---|---|
| Start Value | 1 | < 7 minutes |
| Start Value | 1/2 | < 14 minutes |
| Start Value | 1/3 | < 21 minutes |

TABLE 2

The bandwidth allocated to any of these channels will depend, at least in part, on the amount of the broadcast resource to be allocated to the information service as a whole. For example, if the total amount of bandwidth for the security quote service of the present invention is limited to 2 S-BCCH slots, the allocation could be as set forth in Table 3 for a period when the market is open.

| S-BCCH sub-channel | No. of S-BCCH slots | Cycle time |
|---|---|---|
| Delta | = 1.5 slot (75%) | 1 minute |
| Start Value | = 0.5 slot (25%) | < 14 minutes |

TABLE 3

In such an allocation scheme where only a very limited amount of bandwidth is available, the Security Name channel is transmitted only when the market is closed. For a newly activated mobile, security symbols are used instead of the security name for the first day or the preprogrammed names are used if present.

The security quote service, according to the present invention, may be offered to a user at different subscription levels. For example, a basic service may contain the most widely traded stocks while a premium service might include commodities, currencies and futures. The security quote service may provide one or several services free of charge while allowing access to the other services on a pay per use basis.

In order to control a user's access to those subscriptions in which a fee is being charged, the present invention provides for scrambling (or encryption) of those services. As a result, a user would be required to have a predetermined descrambling (or decryption) key in order to have access to a particular service category.

Once the user has properly been granted access, the mobile is ready to receive and display the service information to the user which has been broadcast over the afore-described logical channels and processed accordingly by the mobile station's processor. The stock information could, for example, be provided to the user on display 190 as follows:

| |
|---|
| ERICY 53 3/8 +1 /8 |
| MOT 58 5/9 + 3/7 |
| LU 71 1/8 - 1/8 |
| NOKA 64 8/9 -3/8 |
| T 63 ½ -1 1/4 |
| SBC 71 1/32 + 3/32 |
| BLS 62 1/16 - 3/16 |

As mentioned above, the Security Name channel provides the necessary mapping to allow, in the alternative, the company name to be displayed.

| |
|---|
| Ericsson 53 3/8 + 1/8 |
| Motorola 58 5/9 + 3/7 |
| Lucent 71 1/8 - 1/8 |
| Nokia 64 8/9 - 3/8 |
| AT&T 63 ½ - 1 1/4 |

South W. Bell 71 1/32 + 3/32
Bell South 62 1/16 - 3/16

Through the use of a function key, the user can scroll through the list of stock information provided on display 190. Several lists may exist for each service level. The present invention also allows the user to organize entries from different lists into folders. For example, a user who owns securities from several lists and several service levels may put those securities into a separate folder. This greatly reduces the need to scroll through entire lists for information that is of the most interest to that user.

In order to facilitate data retrieval, the service information may, as mentioned above, be broken down into categorizes. The information can, for example, be categorized according to the type of business (e.g., telecom, oil, banking, etc.), the market in which the symbol is traded (e.g., NYSE, NASDAQ, etc.), or the type of security (e.g., stock, future, commodity, etc.). The different categories can be set by the service provider and then sent to the user along with the data. It is clear that one security can be associated with more than one category (e.g., telecom and NASDAQ). In order to reduce the necessary bandwidth required, the category information can be sent as a common information element for all or a sub-set of the members of the category. Thus, the lists can be organized such that, for example, the NYSE category is sent first. Within that context, the telecom stocks are sent.

In an exemplary embodiment of the present invention, alarms may be set for individual securities or for an entire folder. For example, triggers may be set to indicate that the change or the total value of one or more securities is outside a specified limit (or box), the relation between two or more securities is outside a box, or the change of the total folder is outside a box. As a result, the triggering of one of the above-identified events could result in, for example, the user being

alerted to the event through an alarm, such as an audio signal, a blinking icon or a vibrator. If the user has set the radio communication device to only receive a specific range of all the lists that it is eligible to receive (e.g., to reduce power or current consumption of the mobile station's battery) and one or more of the securities of interest move out of the specified range, then the trigger may cause the mobile device to start to read a larger or a fuller set of the eligible lists. Moreover, if a security reaches a certain level or moves outside a box, the mobile (if it is a two-way mobile) may send a SMS message or another form of notification to another user or device. This could, for example, be used to send an e-mail message to a broker for selling or buying a security.

As evident from the above description, in order to have a reasonably attractive securities quote service (i.e., one that is fast and provides a large amount of securities) which provides the desired data on the S-BCCH, the amount of data per security must be very small. The present invention divides the data into three channels and controls the bandwidth allocation to these channels depending upon status of the market. For example, allocating a majority of the bandwidth to the Delta channel in the above-described exemplary embodiment makes the stock quote service of the present invention feasible within the bandwidth constraints of the DCCH available today in radiocommunication systems which are IS-136 compliant.

In some countries there may be no stock symbols defined. Instead, the full or abbreviated name of the security is used to identify the security. In this case, the Start Value channel can contain a special identifier, e.g. a number, instead of a security symbol. This identifier is then used in linking the security name broadcast on the Security Name channel to the Start Value channel and, if symbol names or identifiers are used on the Delta channel, from the Start Value channel to the Delta channel. The identifier effectively acts as the symbol name. In fact, the official symbol name, if one exists, is a special type of identifier.

A benefit of having defined symbols, instead of special identifiers, is that the defined symbols can be displayed if the mobile device does not have a stored security name that corresponds thereto, whereas the special identifier may not be recognizable to the user. Thus, for systems which employ special identifiers other than stock symbols, it may be desirable to preprogram remote devices with mappings between the security name and the special identifiers, so that user recognizable information can be readily displayed.

The alternative of transmitting the Security Name channel, especially if the content transmission rate for the Security Name channel is the same as the Start Value and Delta channel contents, is logically equivalent to sending all the information (name, start value, change) in one common channel and one of the benefits of the invention (e.g. low broadcast resource utilization) does not occur.

If the mobile device has a local communication facility, e.g. infrared or wireless link, the data received can be transmitted to a general purpose computer e.g. a PC Laptop. It may be much easier to analyze the data in such a device since mobile modems typically do not have a user friendly or feature rich user interface and application programming. The portfolio of the user may reside in the PC. The PC may have a program for analyzing the information broadcast over the various sub-channels as it is relayed by the mobile station, which program may further alert the user according to more advanced triggers and/or include assessments involving the portfolio of the user.

As mentioned above, the Delta channel may include a time of day indicator associated with the transmitted incremental/decremental values for the securities for which information is provided by the service provider. This time indicator may reflect the time of the last trade associated with these values (i.e. when the presented change value in the Delta channel was valid in the securities market) and/or the transmission time when a batch of values (e.g. the full set of securities contained in the active set) was first sent out on the Delta channel. The service

provider may specify that the values transmitted on the Delta channel reflect trades which occurred some specific, predetermined time in the past, e.g., a delay of 20 minutes.

The time associated with a security's value (according to any of the above mentioned techniques) can be presented to the user on the display of the mobile station. Due to bit errors (or more specifically word errors), some frames (e.g. Layer 2 S-BCCH frames in the context of exemplary IS-136 compliant systems described above) will not be recovered. If the refresh rate of the contents of the Delta channel is the same as the cycle length of the channel, the lost information will never appear again. Thus, the mobile station may have more current value information for some securities than for other securities. Even if the incremental/decremental data is repeated on the Delta channel, there is no guarantee that the second instance of the previously lost data for the particular security will be decodable. Thus, some securities may be displayed using values calculated based on Delta values which are several cycles old.

According to exemplary embodiments of the present invention, the displayed stock value and/or the time indicator can provide a special indication to the user indicating when it has been refreshed by received Delta channel information. For example, a time-faded indicator can be used to indicate the relative time that a value has been refreshed, e.g., by adjusting the color and/or luminance of a displayed value. Alternatively, an icon can be provided on the display to indicate that the value has recently been updated or, conversely, is relatively old. The indication can fade away over several seconds or 10s of seconds, or be related to the refresh rate to the cycle length of the transmission or refresh rate of the update of the changes in the system.

The indication of how recently the information has been updated should be tied to the service provider's refresh rate of the broadcast data, rather than the cycle time for transmitting a complete set of information, if these rates are

different. For example, if the cycle length of transmission is one minute (i.e, a complete set of information is transmitted on the Delta channel every minute) and the service only updates the information every 5 minutes, the incremental/decremental values will be repeated five times before being updated by the service provider. In such cases, the time indicator of the information being displayed should only alert the user as to whether the displayed value is the most recently available from the service provider, not whether the mobile station was able to accurately decode a most recently repeated cycle of the Delta channel if it has already received and decoded the same information in a previous Delta channel cycle. By providing the time for the trade or by use of change indicators in the broadcast channel, the mobile devices will be able to identify the difference between updated contents in the Delta channel and repeated information.

Differences between content refresh rate and cycle time also provide opportunities for adjusting the way in which mobile stations read the Delta channel. For example, using IS-136 as an exemplary technology, the minimum segmented data that can be accepted or rejected is a Layer 3 message. A Layer 3 message can contain up to 255 octets of data. Several Layer 2 frames are needed to carry a full length message. If one Layer 2 word is not recoverable, the entire message can not be presented to higher layers. There may be a mechanism (e.g. numbering) that allows the mobile to re-attempt reading the lost Layer 2 frame if the information is repeated without requiring that the other Layer 2 frames are recoverable.

Since the type of data transmitted via broadcast information services according to the present invention change more frequently than e.g. other system broadcast information, it may be advisable to construct the message length such that it does not require too many Layer 2 frames to be transmitted. This increases the likelihood, for a given frame error probability, to reconstruct complete messages in the first attempt. If a message is lost, typically several entries in the

Delta channel are lost. Typically, several Layer 3 messages are needed to carry the full cycle of the Delta channel. By reducing the length of the messages and correspondingly increasing the number of messages, the mobile can recover more of the data in a cycle for each cycle. If content refresh time is slower than the cycle time, the mobile can, at the subsequent passes, concentrate on recovering the messages lost in earlier cycles.

The broadcast channel, e.g. as part of the Delta channel, can state the number of repetitions in a content refresh cycle and the current cycle number. Using the previous example, the system may broadcast then that the content refresh cycle is five broadcast cycles and that this is cycle two of five. This permits the mobile station to only read repeated information if it was not properly decoded in an earlier cycle or if a new content refresh cycle is beginning, which in turn permits the mobile station to increase its battery life.

Since the content of the Delta channels is grouped into messages, the time stamp (of transmission or trade as described earlier) can be sent as part of the message rather than with every entry in the Delta channel. This reduces the overhead of providing the time stamp data. Similar, any other type of information that is common for the particular Delta channel entries contained in a specific message can be sent once in the message. Common attributes for the other two channel types are equally well suited for bundling within Layer 3 messages. The bundling can also be used on any other layer or segmentation found in the overall protocol.

For example, as described above the broadcast channel can be subdivided into several sub-channels. Several messages can be sent in a sub-channel. Hence, the three channel types according to this exemplary embodiment of the present invention can e.g. be carried in a single sub-channel. Bundling of common overhead is most preferable done on the highest common point in order to reduce the required bandwidth for the attributes. Information of an important nature, e.g.

to identify the particular service on the broadcast channel, cycle length, cycle repetition number, list number, information to decrypt the data etc. may be repeated more than the minimum amount of time, i.e. not only sent once per highest common point in the cycle. If the mobile is not able to read this information it may, depending on the particular type of information, not be able to synchronize to the information stream and must wait for the next appearance. Thus, there is a trade-off, as with all broadcast services, between bandwidth efficiency and time to log-in for newly arrived mobiles.

**Sports Information Service**

Another example of a broadcast information service suitable for sub-channelization for efficient transmission according to the present invention is sports news. Sports information that is displayed in e.g. CNN Headline news in the form of text in a banner can also be efficiently transmitted in a wireless channel.

This channel, referred to herein as the Canned Sports Service(CSS), can be sent in both broadcast and point-to-point mode. The point-to-point mode is an addressed message (or set of messages) sent on the FACCH or SACCH channel, identified by an CSS service identifier. This service can also be accessed from a server using a packet data channel. For the point-to-point mode, the mobile may issue a request for a particular sports result or the mobile may automatically receive the results periodically during the day, in particular when the leagues are playing. In the broadcast mode, no system access is needed.

An example of the information that could be displayed by the CSS is:

New York Rangers - Pittsburgh 2-0

Miami - Detroit 1-4

The first row contains 34 octets. The second row is an example of team names containing relatively few characters in its name. The second row requires

20 characters. The required octets include one "line break" non displayed character and all spaces between names. This display requires 54 characters. In average for the two results above, 27 octets per result is required which is 8*27 = 216 bits. The existing text based SMS service found in most wireless systems (e.g. IS- 136) can be used to send this information. As with the foregoing security quote service, it is an objective of this exemplary embodiment of the present invention to drastically reduce the number bits required to transmit this type of information.

In the United States and Canada, the sports which receive the most interest are organized in just a few leagues. The major leagues are NHL (ice hockey), NBA (basketball), MLB (baseball), NFL (football), etc. This feature of sports information organization can be used to aid in the sub-channelization of sports information for wireless broadcast as follows.

In a first exemplary implementation of the CSS, all leagues of interest are assigned a league identifier (LI) and all teams within a league are assigned a league member identifier (LMI). Thus, the combination of LI and LMI uniquely identifies a team and the type of sport. Assume that there are a maximum of 32 teams in a league. The required number of bits for the LMI is hence 5 bits. Assume that a single digit is sufficient for the result (i.e., 4 bits). The spaces, dashes etc. are not required to be transmitted. The total required number of bits are 5+5+4+4 = 18 bits. Compare this with the text based transmission example which required 216 bits, without considering protocol overhead bits that will need to be transmitted.

This exemplary format used for the CSS is very efficient but not very flexible. One digit for result representation is not sufficient for many sports, e.g., football. The number of teams can be greater than 32. Thus, the format could include a continuation flag indicating whether more digits will follow or using a length indicator describing how many bits are used to describe each numerical

result. Those skilled in the art will appreciate that the provision of length indicators and continuation flags *per se* is known in the art to provide a receiver with information needed to properly read broadcast information, see, e.g., IS-136. A flexible protocol would require a few more bits per result. However, the efficiency is still about 10 times higher than a free format text based transmission.

The protocol used for CSS according to another exemplary embodiment of the present invention contains two channels:

1. CSS Programming channel (CSS-PC), and
2. CSS Results channel (CSS-RC)

The CSS-PC channel contains:

- a CSS-PC identifier
- a league identifier (LI)
- a number of entries
  - a set of league member identifiers (LMI)
  - a name of team

Like the Security Name channel, the CSS-PC can typically be transmitted during times of day when the broadcast channel is not very busy, e.g. during nights. The content of the CSS-PC can also be pre-loaded by the mobile manufacturer, sent to the mobile as part of the over-the-air activation or programming event (when e.g. a phone number is assigned to a mobile) or stored in the device by means of a local communication (e.g. cable, infrared, short radio link services, etc.). The CSS-PC links a name, e.g. New York Rangers, with an identifier, e.g. a number, which mapping can be stored in the mobile station. This identifier is then used by the CSS-RC to indicate the team. The device maps identifiers to team names which are displayed to the user.

The CSS-RC channel contains:

· a CSS-RC identifier

· a LI (1)

· number of entries

· result 1, result 2,..., result n,...,result m

· LI (2)

· number of entries

· result 1, result 2,...,result n,...,result p

· ....

where each "result n" contains 2 LMI and the score. Length indicators, continuation flags etc. and similar overhead which may be added to each "result n" entry to make the protocol flexible in displaying the content are not showed above.

According to another exemplary CSS embodiment, the league identifiers (LI) are replaced by a common set of Team Identifier (TI) for all leagues. For example, the biggest cities in then United States and Canada could be assigned an identifier (e.g. a number). For 1000 cities, 10 bits are needed to represent all cities.

The benefit of TI concept over the LMI is that re-programming is not needed when teams enter or leave a league. Depending on the size of the TIs and LMIs, the required bandwidth (number of transmitted bits) may also differ. Since most of the required bandwidth is used by the results rather than the league identifiers, and since the leagues are known by their abbreviations (e.g. NBA), the league identifiers can be sent directly as text without sacrificing significant bandwidth efficiency. Thus, the TI concept may not need a programming channel at all if a sufficient number of cities are defined. Any sports result between cities X and Y can then be displayed in a bandwidth efficient manner. Only the type of

sport may be sent in an uncoded text format or a combination of LIs and text can be used.

One benefit of the LMI concept is that the full name of the team is displayed rather than just the city, e.g. New York Rangers instead of New York. A further difficulty with the TI concepts arises if there are two teams associated with the same city in a league, e.g., the New York Yankees and New York Mets.

For this second exemplary embodiment the Result channel could then include:

- CSS-RC identifier,
- geographic domain (e.g US/Canada)
- text describing first set of results (e.g. NBA)
- number of entries
- result 1, result 2,...,result n,...,result m
- text describing second set of results
- number of entries
- result 1, result 2,...,result n,...,result p

In the CSS Result channel, using any of the formats defined above, further auxiliary information using pre-defined (canned) formats can be transmitted. By using canned messages the bandwidth requirement is kept at a low level. Examples are illustrated below.

The auxiliary information in the CSS-RC can be indicators defining, for example:

final result
half time
Nth quarter (N=1,2,3,4)
canceled
delayed

In addition, embedded text can also be sent, of particular use when any of the canned messages are not applicable to describe the status of a particular game or match. An example of auxiliary canned information and embedded text are as follows:

| Miami - Detroit 1-4 | Final | *Detroit ready for play-off* |
|---|---|---|

The word "final" is a canned message (requiring just a few bits to transmit which bits are mapped into a set of stored messages in the mobile station, resulting in the display of the word "final"), while the text in italics is embedded text. The more frequently a particular phrase may be transmitted as embedded text and the longer that phrase is, the greater the incentive to provide for a canned solution. For example, *Detroit ready for play-off* can be canned by having Detroit be identified by the LMI or TI and assigning "ready for play-off" to the set of canned messages.

In a third exemplary implementation of the CSS, the pairing of the teams is performed prior to game start. Any technique described above can be used to define the pairs (LMI, TI or text). Before game start, a relatively low amount of bandwidth can be allocated for this purpose since the pair programming of the mobile station is less time critical. A pair of LMI or TI is allocated a Pair Number (PN). For example, a game between the New York Yankees and Baltimore Orioles may be allocated PN = 1 and a game between the Boston Red Sox and the California Angels may be allocated PN = 2. The mobile station can store this information.

When the games starts, only the PN and the results are transmitted. For example, the transmission 1, 2, 1 may be interpreted by the mobile station and displayed as "New York Yankees 2 Baltimore Orioles 1". Alternatively, the results can be sent in the order of the PN. Thus, only the score must be

transmitted, which further reduces the required bandwidth. This exemplary embodiment requires that the mobile station have the pairing information before it interprets the score information. Thus, pairing information could be sent on a separate subchannel from the scoring channel, the former of which need only be read once per day. The transmission of auxiliary information, as described above, is also applicable in this pairing embodiment.

**Other Exemplary Applications**

The present invention can also be used, for example, to provide a broadcast weather service. Weather information can be broadcast on a separate, e.g. from those illustrated in Figures 5-7, programming channel, where areas associated with the weather information (e.g., cities, counties) are identified. This programming channel may have different contents in different regions in a country. The type of weather may also be pre-identified, i.e. defined as canned messages. Embedded text, when no canned message is suitable or messages beyond the available canned information are required, can also be transmitted for this weather application in much the same manner as described above for the sports score application.

Examples of broadcast weather information include the following:

60% chance for rain *Apple Hill festival canceled*

Thunderstorm watch in Wake county from 8:30 p.m.

In the foregoing example, each underlined text segment can be provided as a canned message, i.e, by transmitting an identifier on the weather broadcast sub-channel and retrieving, from the remote terminal's memory, the message for display. The "in Wake County" text can be a locally programmed message, i.e,. only a certain subset of the mobiles may have this message stored in their memories. The text in italics can be an embedded message, i.e., broadcast as

text. The other text segments are so general that they could be part of a common, for all the country, programming message. Thus, the programming channel, which defines the messages and the linkage to a short identifier can have several sub-channels to provide different types of service/bandwidth utilizations. A local, regional and national programming channel is envisioned.

Viewed in isolation, the combination of the amount of text and the required refresh rate of weather information may not be as burdensome to transmit as e.g., security quote information. Thus, this broadcast weather service application may use a straight text format wherein all of the desired information is broadcast directly over a broadcast subchannel. However, when used in conjunction with other broadcast information services, it may be justifiable to develop a channelized format for weather information as well. If the channelization protocol has been developed for other broadcast applications, there is no or very little additional complexity for the remote device to also handle weather information using the afore-described channelized approach.

Another potential application of channelization and encoding techniques according to the present invention is a broadcast news service. This type of information may be less suitable for canned messages than some of the other exemplary embodiments described herein and, hence less suitable for these types of hierarchical channel structures. However, there may be key words that are suitable for canned representation in a broadcast information news service, e.g., The President, The Congress, The Senate, ..., approved, rejected, proposal, election, defeat, legal action, etc. In such cases, a channelized news approach may also be adopted, e.g., in conjunction with one or more of a channelized security quote service, a channelized sports information service, a channelized weather service, etc. Alternatively, news could be provided as a broadcast headline hyperlink service as described in copending U.S. Patent Application Serial No. _____, entitled "A Headline Hyperlink Broadcast

Service and System", to Alex K. Raith and filed on the same date as this application, the disclosure of which is incorporated herein by reference.

Yet another exemplary application for the inventive techniques is a broadcast service for airport information. Examples of information which can be broadcast for such a service include the following:

Flight AA *80* to Stockholm delayed until *6:10* p.m.

As with the earlier example, underlined text can be broadcast and recreated at the terminal as canned messages, whereas the italicized information can be transmitted as embedded text. Note that a user who is only using one airline, can set a filter in his or her remote station to only display flight information related to that airline and, optionally, including general information not pertaining to a specific airline. In this example, the time (6.10) is embedded text rather than a canned message. It will be apparent to those skilled in the art, that many alternatives exist in defining canned messages or relying on embedded text for a particular set of words or time of day.

When severe weather strikes a big airport, such as O'Hare in Chicago, there may be several hundred flights that are affected. Thus, the full list of information may contain hundreds of lines of information similar to the one illustrated above. This information may be updated several times per hour. Thus, the canned text approach does not provide relief in terms of required broadcast bandwidth and a channelized approach providing relationships to reduce the bandwidth of broadcast information on some sub-channels may be desirable.

Filtering of the broadcast information may also be desirable since a user may only be interested in a limited subset of the available broadcast information. For example, a user may enter the flight number of interest into the remote device, e.g.. AA 80. The user is then alerted (e.g., by an audio tone) if

information about the particular flight of interest is present. Change flags or time stamps can be used on the broadcast airport sub-channel to avoid repeated alerts when the same information is subsequently received.

The foregoing exemplary security quote and sports score information services have been described in some detail to explain how channelization techniques according to the present invention can be used to efficiently transmit various types of information in a manner which reduces the usage of scare broadcast resources associated with radiocommunication systems. These techniques can be generalized as follows.

Consider that broadcast information to be processed for display, storage or organization in a mobile station can, according to the present invention, be grouped as sets of information elements which shall be referred to here as "associations". Information elements can be explicit (e.g., a bit flag or field) or implicit (e.g., sequencing). At least two associations are created in an hierarchical manner for a given information service based upon a recognition that at least one of the elements in one association has different bandwidth needs than at least one of the elements of another association. The first association creates a relationship between a relatively high bandwidth consuming element in that association and another element in the association which requires lower bandwidth for transmission. The second association also includes a plurality of elements, including one of which is either explicitly or implicitly part of the first context, thus creating a link therebetween.

This concept is illustrated in Figure 8. Therein, each association is represented by a rectangle. Each information element is represented by a circle within an association rectangle. The circle surrounded by parentheses represents an implicit information element. The horizontal line represents a relationship that is used to efficiently channelize information to be transmitted and the vertical or generally vertical lines represent links between elements in different associations.

Those skilled in the art will appreciate that there effectively exists a relationship between each information element in an association, but that some relationships may be relied upon to provide a mapping in a remote terminal, while others may not. The combination of the relationship between elements within an association and linkage between elements in different associations provides a mechanism for optimization of bandwidth utilization. Generally speaking, the number of associations and number of elements within each association for any particular information service are arbitrary and will be determined by the types of information elements and frequency at which those information elements need to be updated at the mobile station.

To make this abstraction clearer, consider the previously described example of the security quote embodiment now portrayed using the generalized association and element structure as seen in Figures 9(a)-9(c). Therein, a first association is the security name association. Information elements in this association include those which are transmitted relatively infrequently, e.g, the full security name, the name of the stock market associated with this security. Additionally, the symbol name is part of this association since it is desirable to create a relationship between the symbol name and the security name, which relationship can be used to optimize bandwidth utilization for the security quote service.

The second association is the start association. The start association includes, explicitly, the start value information element, the symbol information element and any other information element that may be transmitted somewhat more frequently than the elements in the first association, e.g., dividend update information which informs the user when a particular security is due to pay a dividend. In this example, the order of information sent, e.g., the order of the symbol information element establishes an implicit information element (as

indicated by the parentheses) referred to as sequence number which is related to the symbol information element.

The third association is the delta association. Here the sequence number is explicitly transmitted and provides the link between elements in the second and third association. The change value is also transmitted for each security. By using the two relationships created in the first and second associations, i.e., security name-to-symbol and symbol-to-sequence number, and by linking these elements between associations, the mobile station can read the delta channel and, based on the order of the information presented, display a full security name associated with each value while the system need only transmit a sequence number and a change value.

Alternative examples are shown in Figures 9(b) and 9(c). In Figure 9(b), the sequence number is explicitly transmitted in the second association and implicitly transmitted in the third association. In Figure 9(c), it is recognized that the sequence number could also be an implicit element of both the second and third associations.

Other variations will be apparent. For example, although the examples in Figures 9(a)-9(c) provide for each association to be linked to one association in each hierarchical direction, the various associations may each be linked to one or more other associations in each direction. Moreover, any number of relationships within associations may be provided to reduce the amount of information transmitted in contexts having lower cycle times. Associations may be sent at different times, e.g., during the trading day or after the trading day, or may be sent at the same time. If transmitted at the same time, contexts may be transmitted asynchronously, i.e., with different cycle times and/or refresh rates of their contents. It will be appreciated that the phrase "cycle time" refers to *inter alia* the amount of time between repetitions of the same instance of a particular information element, e.g, the amount of time between broadcasting the change

information element associated with ERICY on the Delta channel. The phrase "refresh rate" refers to the amount of time between updates by, e.g., the service provider of the values associated with each instance of a particular information element, e.g., how often the service provider updates the change value of the ERICY stock broadcast on the Delta channel. The cycle time and the refresh rate may differ for a given sub-channel or association, as well as between different sub-channels and associations. If, for example, the refresh rate is greater than the cycle time, then certain values can be rebroadcast. In such cases, a change flag may be used to indicate whether the currently broadcast information is new or a rebroadcast. By introducing channelization techniques according to the present invention, the bandwidth requirement or the cycle repetition period is reduced for the lowest channel in the hierarchy.

In addition to efficient broadcast resource utilization, channelization and encoding techniques according to the present invention provide another important benefit, specifically the ability of an application program to be aware of the contents of the information which it receives over the various broadcast channels or sub-channels. As compared with, for example, services which simply broadcast text messages for display on a pager, the channelization and encoding techniques presented herein provide the receiving device of explicit or implicit knowledge regarding the type of information that has or has not been received. For example, consider a broadcast information service which broadcasts, in a relatively bandwidth inefficient manner, ERICSSON 53 3/8 +1/2, which message is displayed on a paging device verbatim. Since the message is displayed verbatim, the pager need not know anything about the information that it has received and, accordingly, is unable to readily manipulate this information or recognize whether any particular information has or has not been received.

By way of contrast, the channelization and encoding techniques according to the present invention create structures and relationships between information

elements which, in addition to being bandwidth efficient, can also be used to provide the remote devices with information regarding which information elements have been received and which, for example, were not received due to channel errors. Moreover, the ability of the remote devices to be more easily aware of the contents of the information they receive makes it easier to organize, present and manage data, as well as provides for improved backwards compatibility by allowing new information elements to be added.

The broadcast airport information service provides yet another example demonstrating the benefit of broadcasting information in a channelized format whereby the remote terminal is content aware as opposed to free format text. The driver in a car heading towards the airport would have difficulty in screening the incoming information for all all flights to find information associated with his or her flight, if any.

Although not specifically discussed herein, those skilled in the art will appreciate that network operators and system providers may wish to establish techniques and procedures for monitoring and controlling access to broadcast information service such as those described herein. Specific techniques are described in copending U.S. Patent Application Serial No. _____, to Alex K. Raith, entitled "Broadcast Service Access Control", filed on the same date as this application, the disclosure of which is expressly incorporated here by reference, which broadcast service access control techniques may be combined with the channelization and encoding techniques described herein.

While the present invention has been described with respect to a securities quote service, one skilled in the art will appreciate that the invention would equally apply to other such systems where information is broadcast to a user. For example, it should be noted that the linked (hierarchical) channels described herein can be sent on any type of channel. Thus, any of the information elements transmitted on linked channels within a particular service may be sent on a

broadcast, point-to-point channel or may be entered into the phone by local means (e.g., infrared, cable, local wireless communication) and stored in the device when manufacturing the phone. Thus, the Delta channel, sport score channel, the air-port status channel, etc., could be sent as a point-to-point message rather than on a broadcast channel. The channel linkage allows for using any channel and sending any channel at any unrelated time. Moreover, the way in which logical channels are linked to existing channel structures may be readily varied and adapted to different systems. Many variants and combinations of the techniques taught above may be devised by a person skilled in the art without departing from the spirit or scope of the invention as described by the following claims.

**WHAT IS CLAIMED IS:**

1. A method for providing broadcast information in a radiocommunication system comprising the steps of:

dividing a broadcast control channel into a plurality of logical sub-channels, each logical sub-channel including a plurality of information elements;

linking a first of said plurality of logical sub-channels to a second of said plurality of sub-channels by providing a common information element in both said first and said second sub-channels; and

broadcasting said first and second-subchannels.

2. The method of claim 1 wherein said broadcast information is securities information and wherein:

said first of said plurality of logical sub-channels includes plural instances of security symbol information elements and security name information elements.

3. The method of claim 2 wherein said second of said plurality of logical sub-channels provides plural instances of an end-of-the-day security trading value.

4. The method of claim 3 wherein a third of said plurality of logical sub-channels provides plural instances of a value which represents an amount in which a value of a security has increased or decreased.

5. The method of claim 1 further comprising the step of:

varying an amount of bandwidth assigned to each of said plurality of logical sub-channels in response to a predetermined event.

6. The method of claim 5 wherein said predetermined event is whether a stock market is opened or closed for trading.

7. The method of claim 1 wherein said broadcast channel is a short-message-service broadcast channel.

8. The method of claim 1, wherein said broadcast information is sports information and wherein:

said first of said plurality of logical sub-channels conveys plural instances of league identifiers.

9. A method for providing securities information to a mobile station, said method comprising the steps of:

dividing a broadcast control channel into a plurality of logical sub-channels;

transmitting a list for mapping security symbols to security names to said mobile station over a first of said plurality of logical sub-channels;

transmitting first data representing an end-of-day security trading value to said mobile station over a second of said plurality of logical sub-channels; and

transmitting second data representing an amount in which a value of a security has increased or decreased to a mobile station over a third of said plurality of logical sub-channels.

10. The method of claim 9 further comprising the step of allocating a predetermined amount of bandwidth to said first, second and third of said plurality of logical sub-channels in response to a predetermined event.

11. The method of claim 10 wherein said predetermined event is whether a stock market is open or closed for trading.

12. The method of claim 11 wherein a majority of said bandwidth is allocated to said third of said plurality of logical sub-channels when said stock market is open for trading.

13. The method of claim 11 wherein a majority of said bandwidth is allocated to said second of said plurality of logical sub-channels when said stock market is closed for trading.

14. The method of claim 9 wherein said mobile station is a cellular phone.

15. The method of claim 9 wherein said broadcast channel is a short-message-service broadcast channel.

16. A system for providing broadcast information to a mobile station, said system comprising:

at least one service provider; and

a plurality of logical broadcast control sub-channels for providing different aspects of said broadcast information from said at least one service provider to said mobile station.

17. The system of claim 16 wherein a first of said plurality of logical sub-channels provides a mapping of a security's symbol to the name of the security.

18. The system of claim 17 wherein a second of said plurality of logical sub-channels provides an end-of-the-day security trading value.

19. The system of claim 18 wherein a third of said plurality of logical sub-channels provides a value which represents an amount in which a value of a security has increased or decreased.

20. The system of claim 16 further comprising means for allocating a predetermined amount of bandwidth to each of said plurality of logical sub-channels in response to a predetermined event.

21. The system of claim 20 wherein said predetermined event is whether a stock market is opened or closed for trading.

22. The system of claim 16 wherein said mobile station is a cellular phone.

23. The system of claim 16 wherein said broadcast channel is a short-message-service broadcast channel.

24. A system for providing broadcast information to a plurality of mobile stations comprising:

at least one service provider; and

a plurality of logical short-message-service broadcast channels for transmitting said securities information provided from said at least one service provider to said mobile station;

wherein a varying amount of bandwidth is allocated to each of said plurality of logical channels in response to a predetermined event.

25. The system of claim 24 wherein said predetermined event is whether a stock market is open or closed for trading.

26. The system of claim 24 wherein each of said plurality of logical channels provides a different type of security information.

27. The system of claim 24 wherein a first of said plurality of logical channels provides a mapping of a security's symbol to the name of the security.

28. The system of claim 24 wherein a second of said plurality of logical channels provides an end-of-the-day security trading value.

29. The system of claim 24 wherein a third of said plurality of logical channels provides a value which represents an amount in which a value of a security has increased or decreased.

30. The method of claim 9 further comprising the step of alerting a user of the mobile station when said second data reaches a predetermined value.

31. The method of claim 1, wherein said information is transmitted using any one of TDMA, CDMA or hybrid access methodologies.

32. A method for channelizing and broadcasting information in a radiocommunication system comprising the steps of:

creating at least a first association and a second association, each having at least one information element;

mapping a first information element in said first association to a second information element in said first association;

providing said second information element, either implicitly or explicitly, in said second association to create a link between said first and second associations; and

broadcasting said first and second associations.

33. The method of claim 32, wherein each information element has a plurality of instances associated therewith.

34. The method of claim 32, wherein said first association is a security name context, said first information element is a security name and said second information element is a security symbol.

35. The method of claim 34, wherein said second association implicitly includes a sequence number information element and explicitly includes said a security symbol information element.

36. The method of claim 32, wherein said first association is a sports program association, said first information element is a team name and said second information element is a league member identifier.

37. The method of claim 32, further comprising the steps of:

broadcasting said first association is broadcast with a first cycle time and,

broadcasting said second association with a second cycle time, wherein said first and second cycle times are different.

38. The method of claim 32, further comprising the steps of:

broadcasting said first association is broadcast with a first cycle time and a first refresh rate, wherein said first cycle time is different than said first refresh rate.

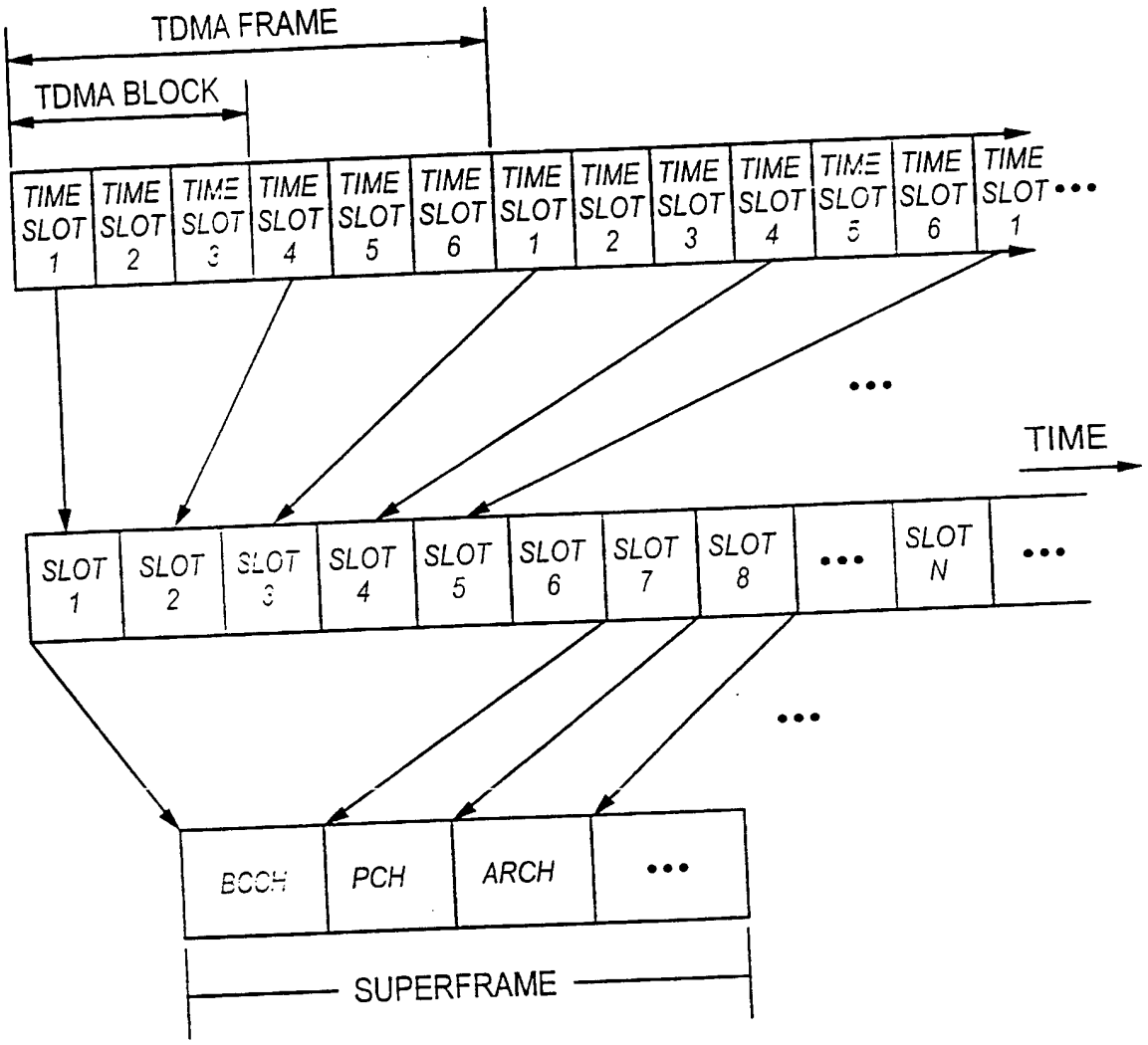



FIG. 1

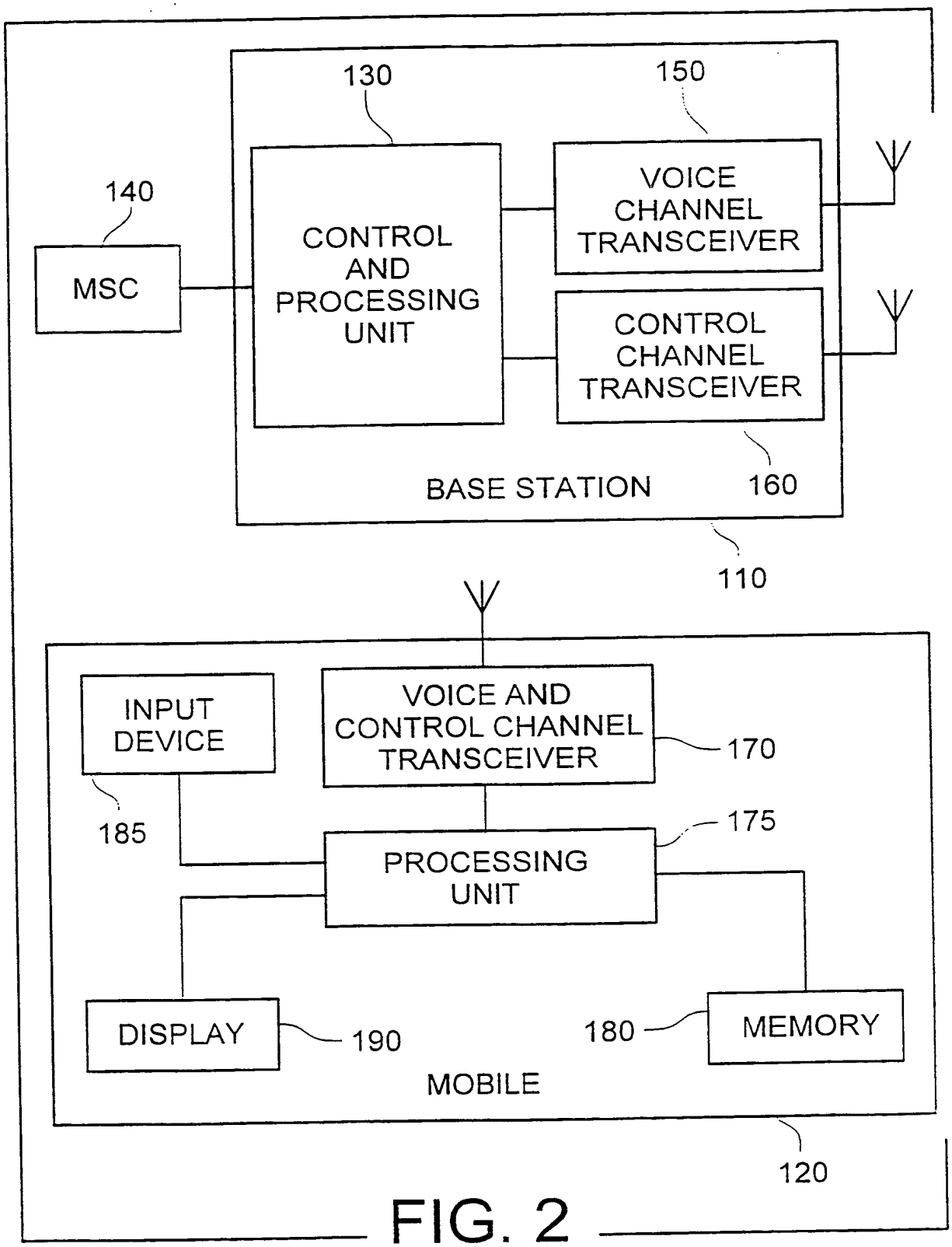
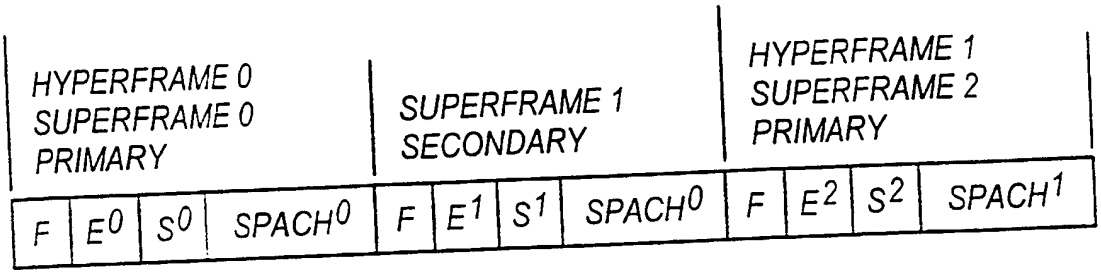



FIG. 2

FIG. 3




F = F - BCCH
E = E - BCCH
S = S - BCCH
SPACH = PCH OR ARCH OR SMSCH

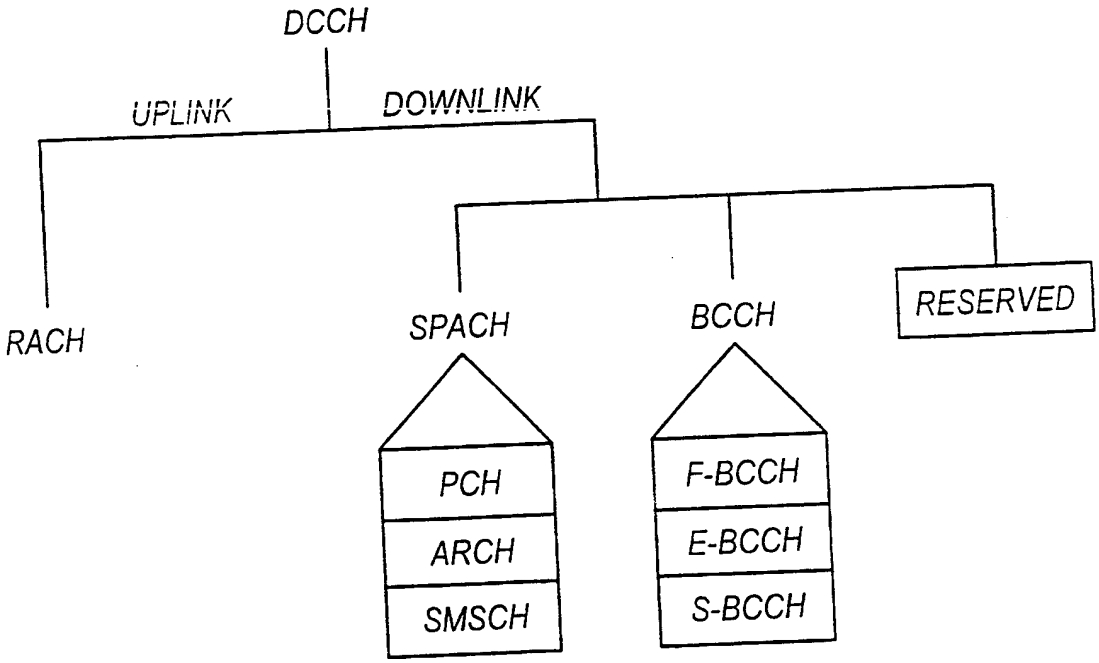



FIG. 4

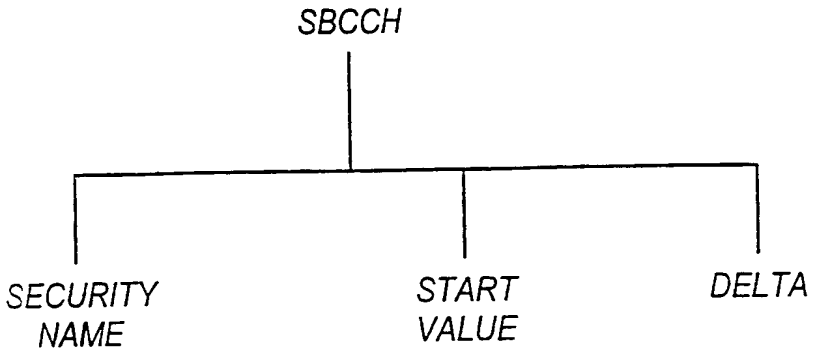



FIG. 5

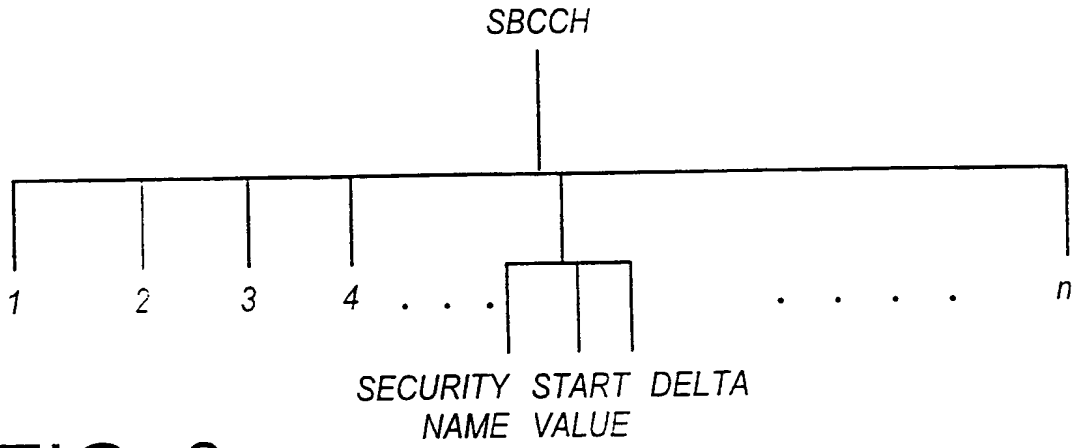



FIG. 6

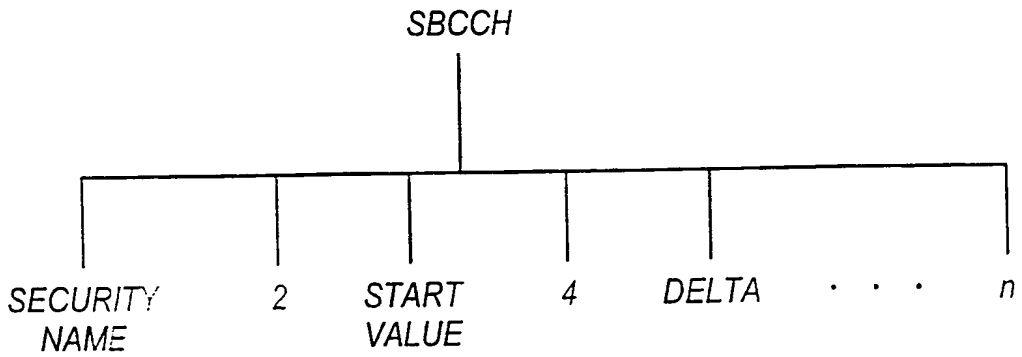



FIG. 7

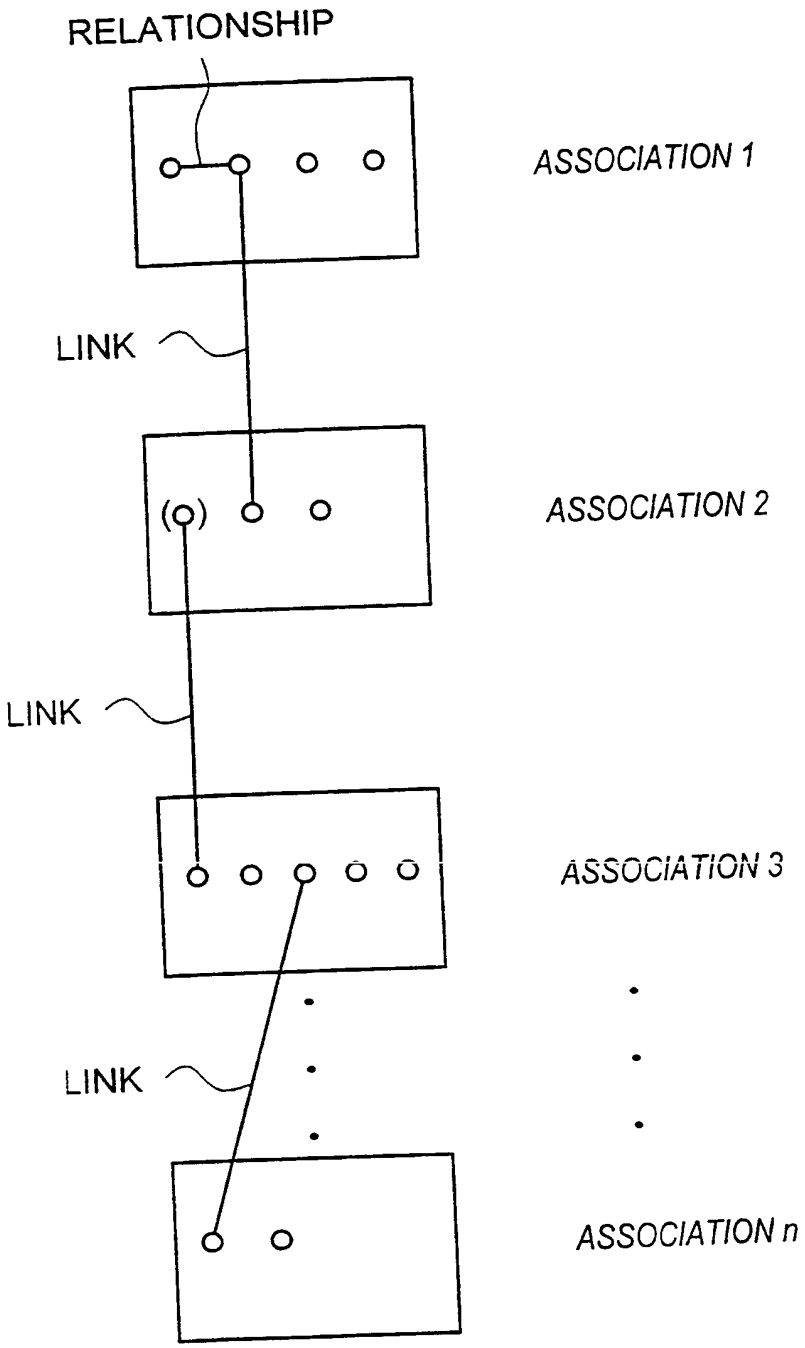



FIG. 8

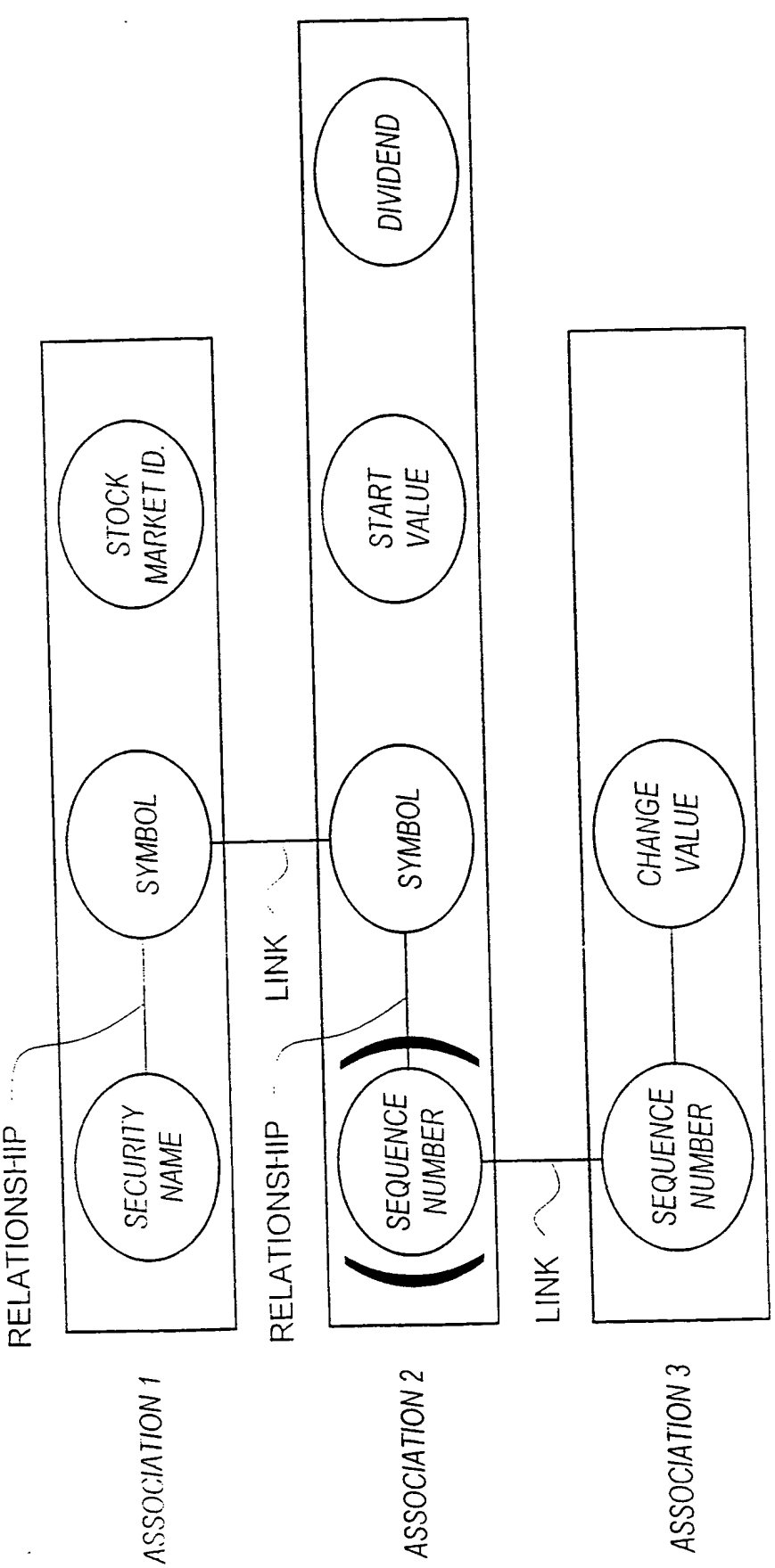



FIG. 9A

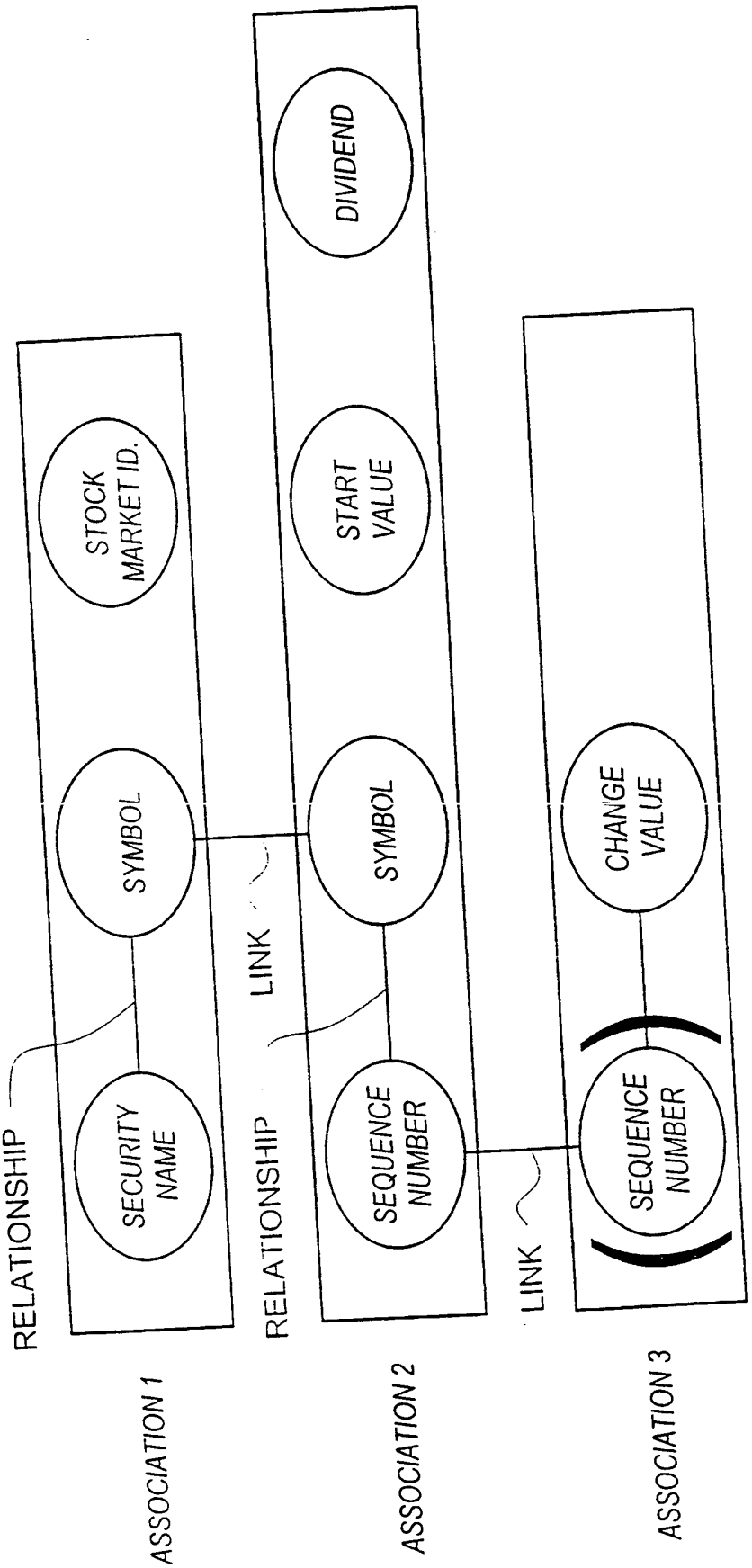



FIG. 9B

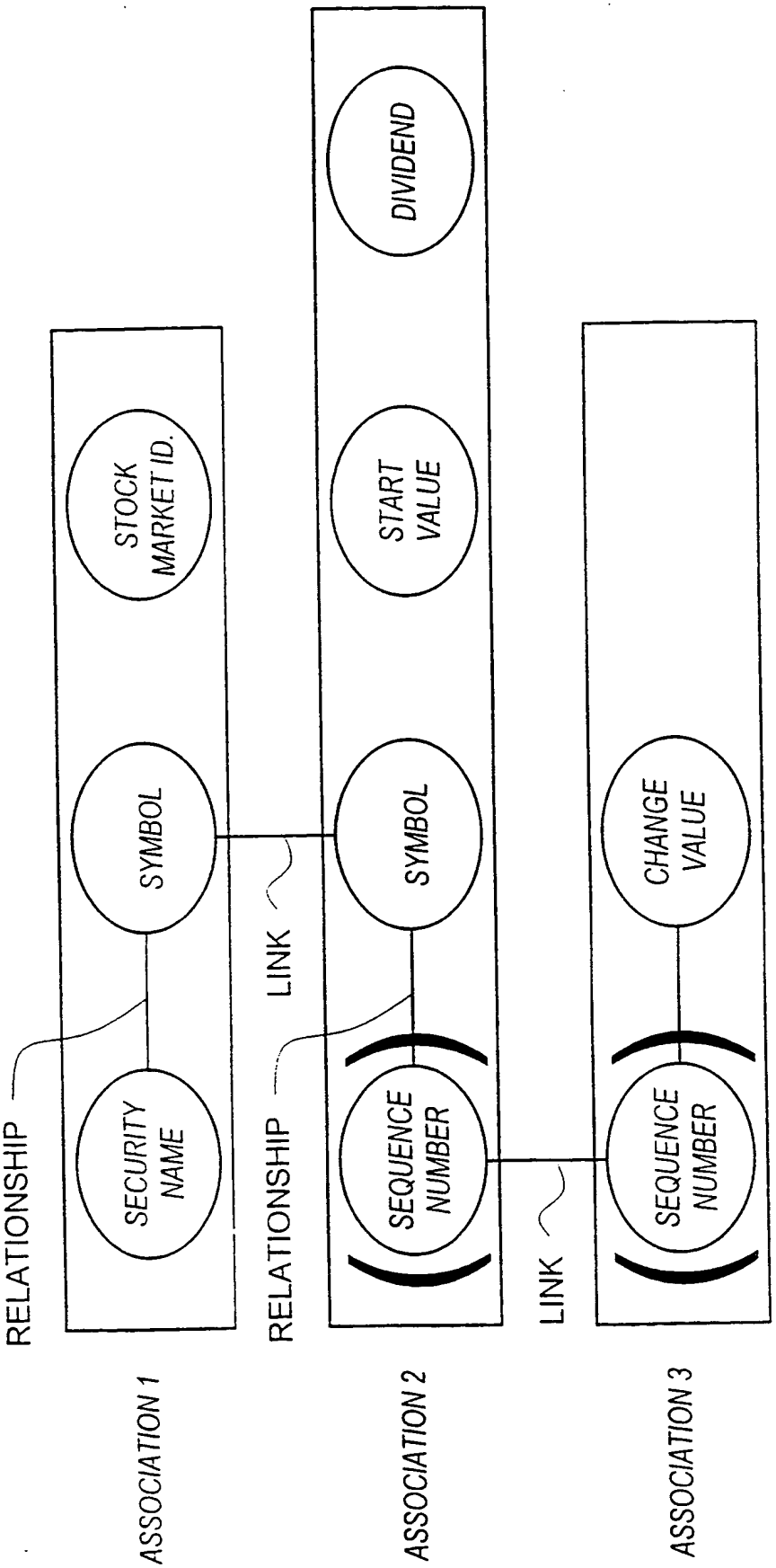



FIG. 9C

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 99/00876

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | WO 98 10605 A (NOKIA MOBILE PHONES LTD ;NOKIA MOBILE PHONES INC (US)) 12 March 1998 (1998-03-12)<br><br>abstract<br>page 2, line 15 -page 3, line 20<br>page 4, line 15 - line 30<br>page 10, line 12 -page 11, line 23<br>tables 1-3<br>claim 1<br>figure 2<br>---<br>-/-- | 1-3,5,<br>7-10,<br>14-17,<br>20,<br>22-24,<br>26,31-33 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 11 October 1999 | 19/10/1999 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Gautier, L |

1

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | WO 96 41493 A (ERICSSON TELEFON AB L M)<br>19 December 1996 (1996-12-19)<br><br>& US 08/482754 (cited in the application)<br>the whole document<br>----- | 1,7,9,<br>14-16,<br>22-24,<br>31,32 |

1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/SE 99/00876

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 9810605 A | 12-03-1998 | AU 4164297 A | 26-03-1998 |
| WO 9641493 A | 19-12-1996 | US 5768276 A | 16-06-1998 |
| | | AU 6020296 A | 30-12-1996 |